

NATIONAL EXAMS DECEMBER 2002

98-CIV-B2, Advanced Structural Design

3 Hours Duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. Any non-communicating calculator is permitted. This is an Open Book Exam. Note to candidates: you must indicate the type of calculator being used, i.e. write the name and model designation of the calculator, on the first inside left hand sheet, of the exam work book.
3. Any five questions constitute a complete paper. Only the first five questions as they appear in your answer book will be marked.
4. All questions are of equal value.
5. All loads shown are unfactored.
6. For figures in Imperial Units and SI, refer to pages 4 and 5, respectively. Solutions in either units are acceptable.

USE THE FOLLOWING DESIGN DATA

Design in	Imperial Units	SI
Concrete or Steel	$f'_c = 4 \text{ ksi}$, $f_y = 44 \text{ ksi}$, $n = 8$	$f'_c = 30 \text{ MPa}$, $f_y = 300 \text{ MPa}$, $n = 8$
Prestressed Concrete	f_c (at transfer) = 5 ksi, $f'_c = 7 \text{ ksi}$, $n = 6$ $f_{ult.} = 250 \text{ ksi}$, $f_y = 210 \text{ ksi}$ $f_{initial} = 170 \text{ ksi}$; losses in prestress = 35 ksi	f_c (at transfer) = 35 MPa, $f'_c = 50 \text{ MPa}$, $n = 6$ $f_{ult.} = 1750 \text{ MPa}$, $f_y = 1450 \text{ MPa}$ $f_{initial} = 1200 \text{ MPa}$; losses in prestress = 240 MPa

1. The cross-section of a simply-supported bridge in Fig. 1, is to be designed in composite construction (unshored). Design the cross-section for flexure and shear transfer between the R.C. slab and the steel girders.

[Assume 100% interaction between the R.C. slab and steel girders, and that the steel girders are adequately braced laterally.]

2. The prestressed post-tensioned concrete girder, shown in Fig. 2, has two tapered overhangs, AB and CD.

(a) Design a constant cross-section for span BC and a tapered cross-section for the overhangs AB and CD, allowing no tension in the cross-sections.

(b) Determine the area and profile of the prestressing steel.

[Use the gross-section in calculating the moment of inertia of the section].

3. The welded steel plate girder, in Fig. 3, is to be designed using a stiffened web design. Determine a suitable cross-section, adequate for:

(a) Flexure; (b) Shear; and (c) Flexure and shear interaction.

[Assume adequate size for the load bearing base plates.]

4. The steel rigid frame in Fig. 4 is to be designed with a constant plastic moment capacity M_p .

(a) Design a uniform steel section for the frame.

(b) Design the welded square corner connection at joint B.

[Assume adequate lateral support at all joints and load points and neglect the effect of axial and shear deformation.]

5. For the rigid steel frame in Fig. 4:

(a) Check the adequacy of the steel section chosen for the beam-column AB.

(b) Carry out a preliminary design for a reinforced concrete footing at A. Assume a value for the soil bearing capacity.

[Assume adequate lateral support at all joints and load points.]

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6. The reinforced concrete rigid frame in Fig. 5 is to be designed with a constant rectangular cross-section. Use the ultimate strength method for flexure and shear, to design the member BC.

[Assume adequate lateral support at all joints and load points.]

7. The two-span continuous girder in Fig. 6 is to be constructed in reinforced concrete. Using the ultimate strength design method for flexure and shear:

- (a) Design the girder AB for flexure and shear, using a uniform rectangular section.
- (b) Estimate the immediate and long-term deflections at mid-span of AB.

[Assume an adequate size for the load base plates.]

NOTE: BRIDGE SPAN = 56 ft.
 USE EQUIVALENT LINE LOAD FOR DESIGN:
 0.35 kip/ft²

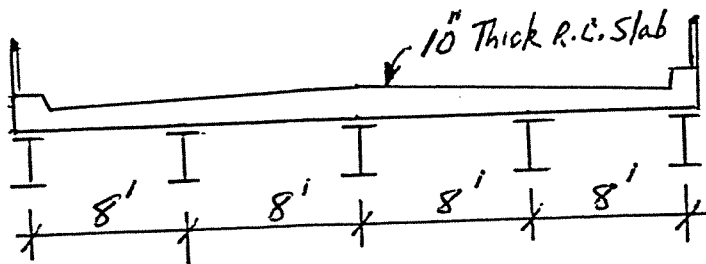


FIGURE 1

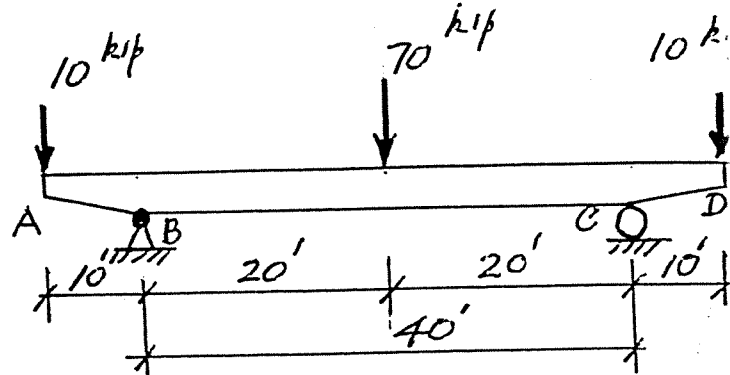


FIGURE 2

NOTE: LATERAL SUPPORT PROVIDED
 @ 10' INTERVALS

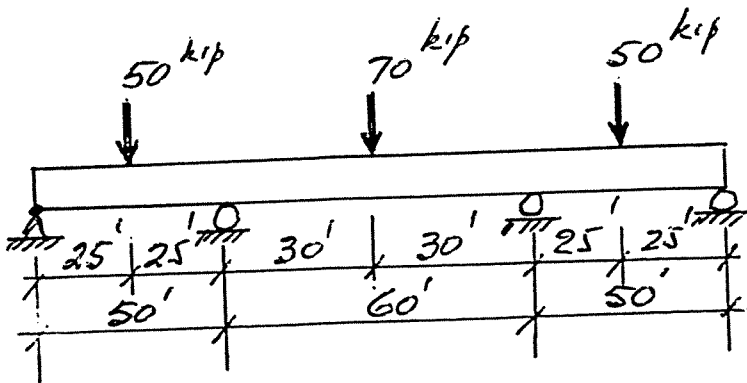


FIGURE 3

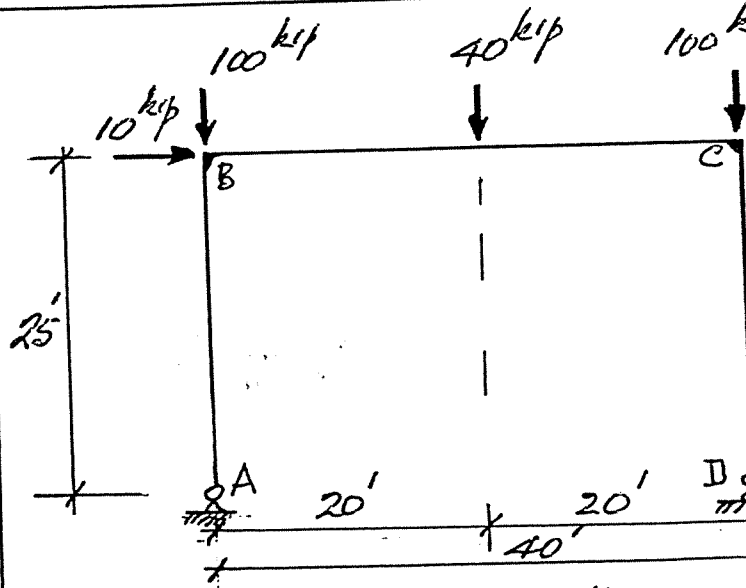


FIGURE 4

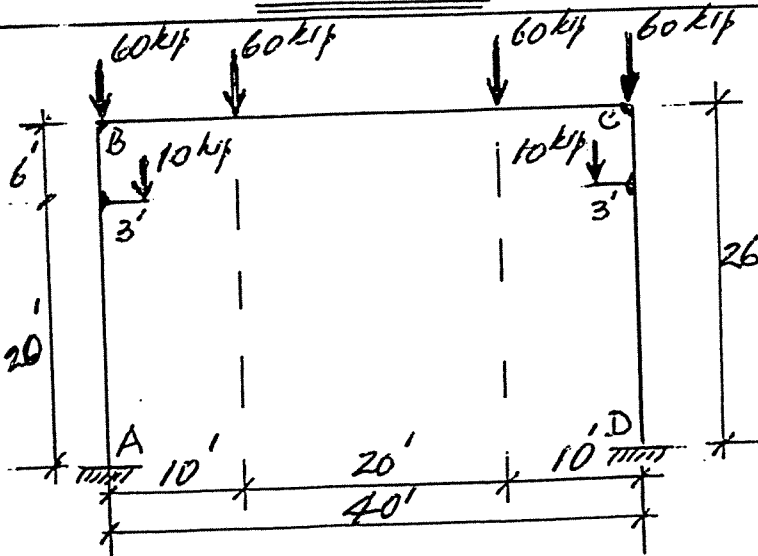


FIGURE 5

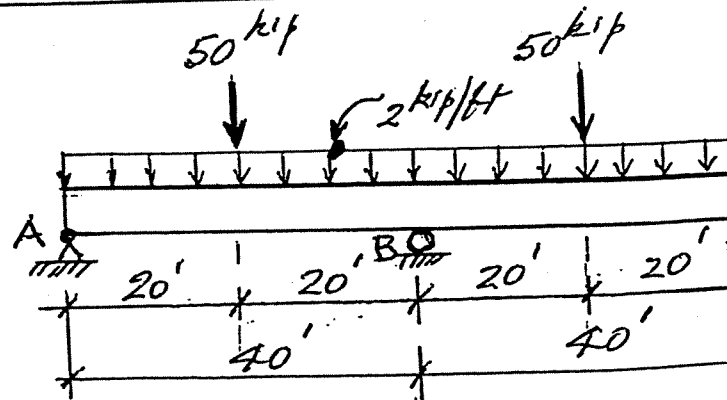


FIGURE 6

NOTE: BRIDGE SPAN = 17^m.
 USE EQUIVALENT LIVE LOAD FOR DESIGN:
 16 kPa

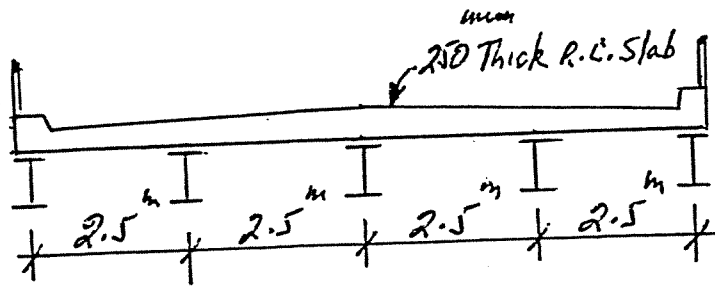


FIGURE 1

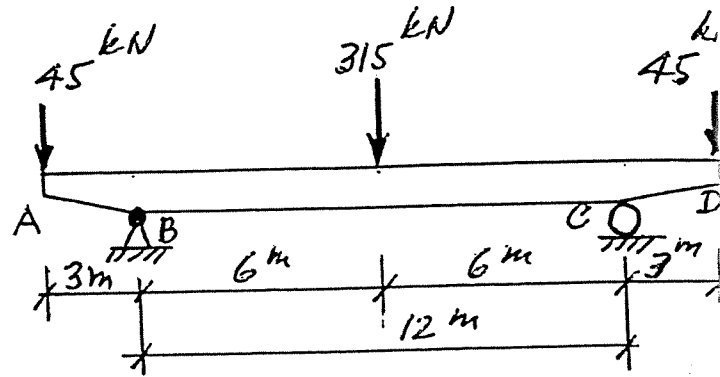


FIGURE 2

NOTE: LATERAL SUPPORT PROVIDED
 @ 3m INTERVALS

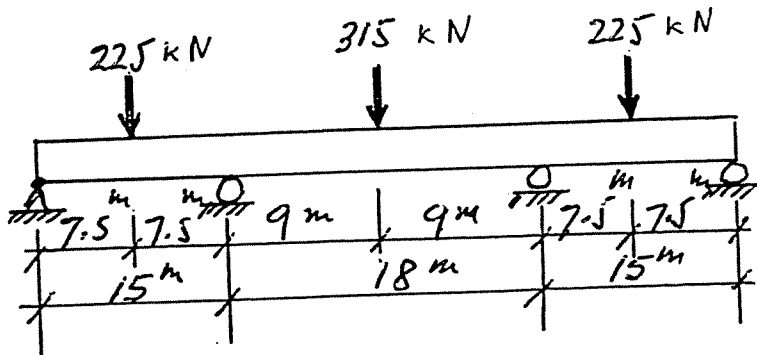


FIGURE 3

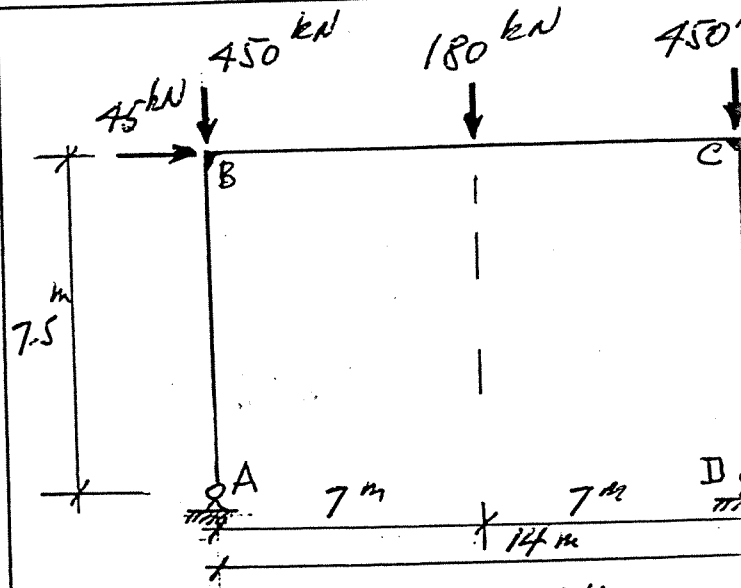


FIGURE 4

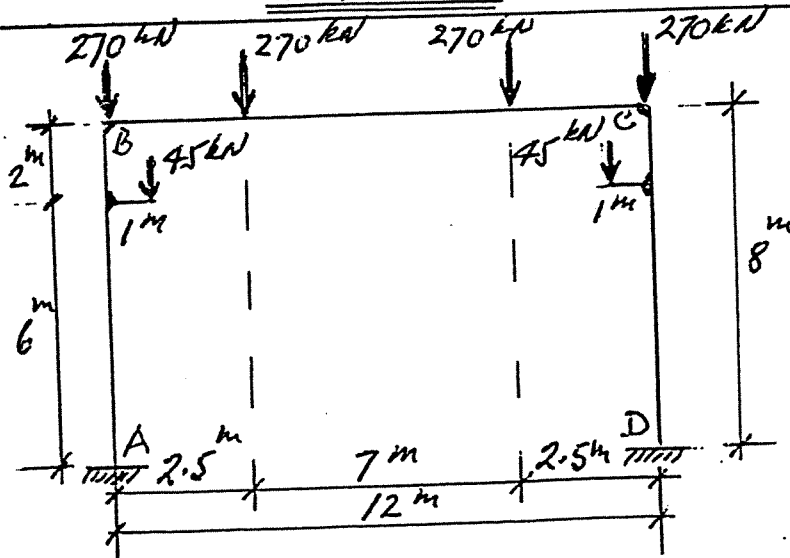


FIGURE 5

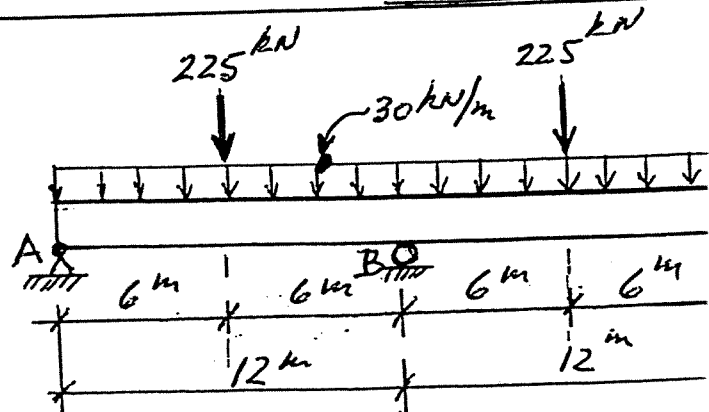


FIGURE 6